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The Effect Of Pictorial Signs On Recycling Rates

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by

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Abstract

Recycling is a core way that college students can act altruistically. Many studies have been conducted to study how to increase the participation of recycling on college campuses, office buildings, and the like. This study focuses on the University Lutheran Chapel, a Christian church adjacent to the University of Nebraska – Lincoln. While the University of Nebraska – Lincoln has drastically improved recycling participation in recent years, the University Lutheran Chapel lags behind. Pictorial signs were used in an experiment to determine whether they improved recycling rates at The Chapel. Recycling rates at the University Lutheran Chapel were measured by counting cups distributed and cups recycled during weekly Sunday lunches. After a baseline collection of six weeks, pictorial signs depicting recyclable materials were posted above recycling bins and three weeks of intervention data were collected. Data collected showed a higher overall percentage of cups recycled during the intervention period over the baseline period. The percentage of the intervention data was not significantly different than the overall percentage of the baseline data. It could not be confidently concluded that the pictorial signs were the reason for the increase in percentage of cups recycled. Injunctive norms may have been observed

causing an impact on the rates, as the recycling percentage rose steadily throughout the baseline period. More research needs to be conducted on how injunctive norms can be used to impact recycling, especially in a church setting. A higher sample size and longer periods for both baseline and intervention would have led to a more confident conclusion.

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Introduction and Literature Review

Since the creation of plastic in the 1950's, the world has struggled to find a solution to controlling the use and reuse of plastics. There are many problems that are being caused by a misuse of plastics, mainly by either littering or throwing it away with common waste. Discarded plastics end up in streams, rivers, and oceans. The oceans' abundance of plastic has been a source of great concern recently. Micro and macro plastics pose a threat to marine wildlife (Barnes et al., 2009). The damage is widespread; plastics of all sizes are distributed all around the world to the order of tens of thousands of tons, often collecting in convergence zones (Cózar et al., 2014).

Modern household recycling began in America during wartime. The onset of World War II made recycling of metal, rubber, and other household items a necessity since much of the materials in the United States were being used for the war effort. After the ending of the war, demand for recycling products declined, consumption took over, and recycling habits were abandoned.

Interest in sustainable action increased steadily, culminating in the first ever Earth Day in 1970. The 1980's saw a small suburb of Philadelphia become the first city in the United States adopt mandated recycling. California began single-stream recycling in 1995, which is the system largely used today. Single-stream recycling is still widely used in the United States today, despite much of the recyclable waste ending up in the landfill as a result. In 2006, Seattle was one of the first large cities in the United States to mandate recycling. Through the rest of the 21st century, more cities have mandated recycling (A Brief History of Household Recycling). Despite the concerted effort, there is still much waste ending up in landfills that is recyclable, which has led many to researching how to improve recycling rates.

Researchers have found that recycling is largely an altruistic behavior that can be imposed on someone through intervention. Having a central, respected figure who can instruct group members on how and why to recycle is the most effective way of altering behavior. Respected figures are the most effective method of changing behavior because they can cause a social norm to be perceived by those who look up to that person. When they

see an idol of theirs recycling and encouraging them to recycle as well, individuals feel more obligated to follow suit. This is most effective when the prominent person communicates the consequences of not recycling. The relating of consequences changes the perceived social norm in the individual to a behavioral norm. A less effective method of intervening with the goal of changing behavior is by prompting potential recyclers with passive signs. Even less effective is only providing information to the potential recyclers about when and where to recycle (Hopper & Nielsen, 1991). One way to increase the effectiveness of education is by tailoring the information to the audience (Abrahamse & Matthies, 2012). Making the information applicable and prudent to a certain group can make the education have more lasting effects.

While providing information is the least effective of the behavioral interventions, it should still be one of the first steps when improving recycling rates in a community. Educating the community on the purpose and importance of recycling can have significant effects on its own; while educating followed by social influence from community members leads to even greater success (Hornik et al., 1995). Education is also simpler than other techniques that require playing on norms individuals hold.

There are a couple reasons individuals lack knowledge on recycling. Knowledge of and passion for recycling often originates from parents' behavior (Matthies et al., 2012). When parents do not share their knowledge, nor set an example as a recycler, their children often have little or no recycling behavior. Possibly connected, of college students who don't recycle, the majority say a lack of awareness of recycling opportunities prevents them from recycling (Wilcox, 2014). There are times where people might be open to the idea of recycling, but have no idea on where to start. Therefore, education is an important first step because many people will be educated on the topic for the first time.

There are several changes that can be made to improve recycling rates. Recycling effectiveness is higher when receptacles are placed in the area where the recyclable materials are being used. Ludwig et al showed that placing a recycling receptacle inside of a classroom instead of in the hall just outside the classroom improved on the overall recycling rates (Ludwig et al., 1998). When the receptacle was near where the recyclable material

was being used, students were more likely to properly recycle because they didn't have to carry the material out into the hallway with them. After the period when recycling bins were in the room, bins were returned to the hallway. Once the bins were removed from the room, students returned to their habits of throwing everything in the trash can in the classroom. This experiment shows that while recycling education is helpful, people often still need to be nudged towards acting on their knowledge. In this case, the students knew recycling was an option, but when the receptacles were in an inconvenient location, their knowledge didn't correlate to results.

Signage is a common way of increasing recycling participation. Pictures or words can be used to instruct what to recycle, where to recycle, or why to recycle. Including signage with recycling bins increases recycling rates over bins without any signs. Lee's experiment showed that while placing a recycling bin in every room was an improvement over central recycling, it was still less effective compared to bins that had signs posted above them (Lee & Ralston, 2003). Installing signage in proximity of recycling receptacles also helps increase the recycling rates of an office setting. Sign prompts above recycling receptacles led to a 54% increase in recycling over receptacles without any signage (Austin et al., 1993). When signs were placed 4 meters away, there was only a 17% improvement. While any signage will increase participation, the closer signage is to a receptacle, the more likely an individual will follow that signage.

Efforts have been made to maximize the recycling participation and overall waste diversion. Studies have been conducted to analyze current proceedings at Universities and Colleges, as well as poll students and staff to gauge what changes could be made to further encourage recycling. Kelly et al. found that students and staff agreed they would be more inclined to recycle if there was better education on what happens to recycling materials after they are dropped off (Kelly et al., 2006). In the same study, students reported they would prefer for recycling stations to be available everywhere on campus so they could recycle more. Lastly, the students agreed there was a need for "improved and increased signage." Students have a desire to increase their recycling rates and change the overall success of recycling on campus. While new recycling bins could cost hundreds of dollars apiece, altering of signage can be a simple change and can be changed in the short term.

Scott Geller et al. found that incentivizing college students with a reward for recycling increased the rates at which they recycled (Geller et al., 1975). Dorm residents were more likely to recycle when there was either an active contest or raffle. Students nearly doubled the baseline weight of paper they recycled through these two programs. Incentives are one of the ways to motivate students to recycle. Providing incentives for recycling is not always a realistic method for some groups that do not have the financial means to compensate students for their activity. Groups and individuals can use nudges to intervene and alter the behavior of those who don't recycle or don't recycle enough.

The University Lutheran Chapel (ULC), or briefly The Chapel, is a Christian church that consists mainly of students who attend the University of Nebraska-Lincoln (UNL). Adjacent to UNL, ULC shares many qualities and goals with the university. The Chapel has made efforts to keep up with UNL's standards concerning recycling as well as other initiatives. The University has a dedicated sustainability team and as a result can boast a waste diversion rate of 58% while recycling 45% of office waste (Reduce, Reuse, Recycle!; recycling.unl.edu). Chapel leaders assert the community within the church is failing to meet recycling numbers that are comparable to UNL. In the past, ULC has had a low weight of recycling by percentage of waste. In October of 2019, the Chapel reopened from a yearlong renovation. In the old, unrenovated building, there was a single recycling station on the first floor. The Chapel has appointed members of the community to improve the rates of recycling observed prior to the renovation. There are several facets of recycling in the building where the ULC leadership sees strong potential for improvements.

Keeping in mind research done in the past and the past trends in the ULC community, there are a handful of changes that can reasonably be made. Some of these improvements include:

1. Improve the availability of recycling
2. Educate the community of the importance of recycling
3. Educate the community on what materials can and can't be recycled

4. Change the culture of the community by using vocal leaders to encourage others to follow in their actions

The Chapel has traditionally had a limited number of recycling receptacles. While there is a trash can in every room of the building, there is only one main recycling station. Staff with offices get to elect whether they have a recycling receptacle in their room. To reiterate, Ludwig et. al found that not having recycling in rooms correlates to a decrease in recycling rates. If it is more convenient for someone to throw away an item than keep it until they find a recycling receptacle, they will often choose the easier route of throwing all waste away. If recycling receptacles and stations were placed next to every trash bin, or in every room at the very least, recycling rates would increase. Making recycling just as convenient as throwing plastics and paper away would immediately improve results.

The Chapel can follow UNL's example and make an extra effort to educate the people who enter their building on recycling. One way ULC could actively educate the community is by making recycling-related announcements during worship service and structured bible study time. In both settings, there is a space for announcements to be made to the whole community in attendance with full attention. Chapel leadership members could give a brief summary on the importance of recycling and a short guide on how and what to recycle. The Chapel can passively educate the community by posting signs on bulletin boards and above trash cans that communicate the problems that come with not recycling. Passive educational posters could have a variety of messages that could persuade the community with logical and/or ethical arguments.

Other passive educational materials could be pictorial descriptions of items that can or cannot be recycled. Many universities and cities create infographics that help to explain recycling procedures in an easy-to-understand way. Often, the infographics have limited words and rely mostly on pictures to guide users to sort their waste properly (*Figure 1*). Infographics could be posted either on the front of recycling receptacles or on the wall above the bins to improve recycling rates at ULC. Visually appealing infographics can catch the eye of

an individual preparing to throw out their waste. When the individual sees the sign and compares it with their waste, the individual might elect to recycle and item they would have otherwise not recycled.

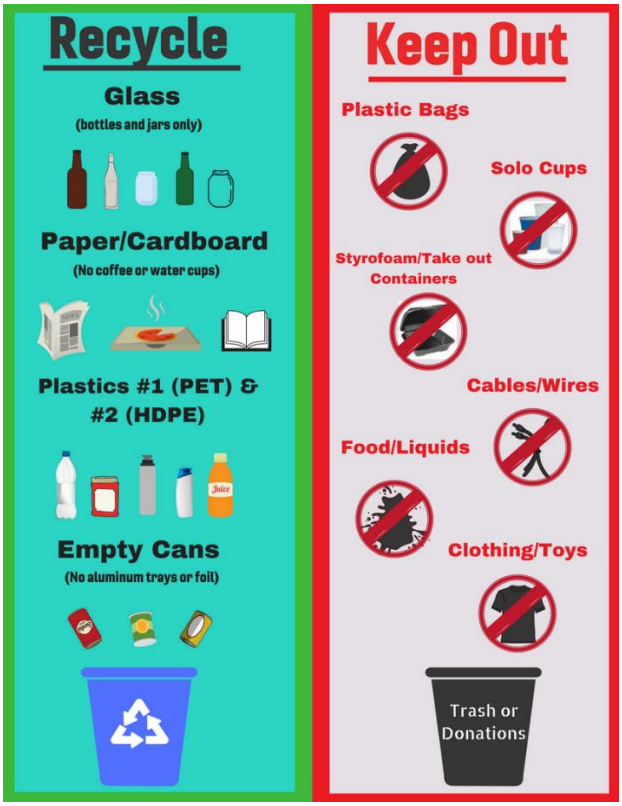

Figure 1. This is a recycling infographic published by the facilities department of Virginia Tech University (VTU). VTU suggests to students, "when in doubt, throw it out," but offers this guide to aid students in their sorting of waste (Recycling; facilities.vt.edu).

Finally, ULC could use the leaders of the church to influence the community to improve their recycling habits. Playing on the concept of social norms influencing behavior, respected figures of ULC, such as the pastor, can distribute materials that convey the leaders as waste-conscious individuals. If there were posters on the bulletin board of the pastor recycling his water bottle when finished, it would create a social norm. That social norm encourages the individual to recycle as well so they can match the activity of someone they look up to. Additionally, if the poster said something like, "Pastor recycles, you should too," that would create an injunctive norm. The individual would be inclined to recycle, because they would not want the pastor to think less of them.

Sunday lunches are a potential recycling scenario at ULC that needs to be focused on. Once a week, ULC hosts a lunch for the members of the church community. Plastics are regularly used for serving and eating during the meal and rarely are plastics diverted from landfill-bound trash cans. Recycling receptacles are not always located in the same places where members of the community eat their meals. Even when recycling receptacles are available, plastic cups are often thrown into garbage cans with the rest of the lunch waste.

Recycling rates during ULC lunches can be improved by employing the same community-wide improvement strategies described above. By relating those four strategies to the sanctuary, where the lunches are held, you could have the following improvements:

1. Increase the number of recycling receptacles in the sanctuary from zero to one, which would match the number of trash cans.
2. Lunch servers could inform people as they receive their meal that it is important to recycle the cups.
3. Recycling receptacles in the sanctuary could have signs on them that instruct the members on what to recycle. Signs specific to lunches could be posted above the recycling receptacle could show that plastic cups specifically should be recycled after lunches.
4. Leaders of the church could be stationed at the recycling and trash directing different waste. In doing so, this would create an injunctive norm.

A combination of strategies one and three and will be used to analyze the recycling participation at ULC. The number of recycling receptacles throughout the building will be increased prior to the experiment.

A simple experiment will be conducted to determine whether pictorial signage has an impact on recycling rates in the context of ULC Sunday lunches. The data will be used to see if the ULC community reacted positively to the addition of new signs that explain what should and should not be recycled. It is hypothesized that the presence of the pictorial signs will increase the rates of recycling compared to the rates with no signs present.

Methods

The experiment will last 12 weeks. Recycling bins will be placed directly adjacent to trash cans. Every trash can will have one recycling can that accompanies it. The first 6 weeks of data collection will be a baseline without any variation from ordinary lunches at ULC. The second 6-week period will have an intervention to influence recycling behaviors. Recycling rates will be determined by examining what percentage of cups are recycled before and after signs with pictures of recyclable materials are posted. The conditions each week will be recorded and any externalities will be identified.

Before anyone arrives at church on Sunday, recycling trash bags will be taken out so they are empty for lunches. Before ULC members come through the lunch line, plastic cups will be counted and set out in groups of ten. A member of ULC's leadership will sit near the cups. When the number of cups remaining is less than ten, an additional ten cups will be set out. When cups are removed from the storage bag to set out, the number of groups of ten will be recorded. Total cups distributed will be determined by counting the number of cups remaining on the counter after 15 minutes have passed since the last person went through the line. That number will be subtracted from the total number of cups set out (a multiple of 10). The number of cups recycled will be determined by removing plastic cups from the recycling receptacles and counting them.

The first six weeks of the experiment will be the baseline without any signs above the recycling bin (*Figure 2*). The number of plastic cups distributed for ULC lunches will be counted as individuals pass the serving line. Two hours after the lunch, or when all individuals leave, the number of plastic cups that were recycled will be counted from recycling receptacles. The percentage of plastic cups recycled will be noted for each week. After the six weeks, all plastic cups distributed will be tallied, as will all plastic cups recycled A total percentage of plastic cups recycled will be calculated as the baseline percentage.

Figure 2. Recycling bins placed adjacent to trash cans without a recycling infographic above the recycling bin for the baseline testing. Beginning with the second week, black trash bags were also placed inside the recycling bins. December 19, 2019.

Week 7 through week 12 will have an intervention to influence the behavior of the individuals attending ULC lunches. The weeks with the intervention will have signs above the recycling bins at all locations on the first floor that show in an infographic what can be recycled, as well as what cannot (*Figure 3,4*).

Figure 3: The sign that hangs above each of the recycling bins in ULC. The sign shows with pictures what can and cannot be recycled in the bins. April 10, 2020.

Figure 4: Trashcans were placed next to recycling bins with a sign above them, describing recycling practices. The sign was a little below eye-level so it would catch the eye of the would-be recycler. April 10, 2020.

As before, the number of plastic cups distributed during ULC lunches will be counted, as will the number of plastic cups recycled. The percentage of plastic cups recycled will be calculated each week. After the six weeks of intervention, the total number of plastic cups distributed during ULC lunches will be added, as will the total number of plastic cups recycled. A total percentage of plastic cups recycled during the second six weeks will be calculated to represent the intervention period.

A two sample t test will be used to determine whether the observed changes are statistically significant. The two sample t test will compare the two means of baseline and intervention data and produce a value that will say with what percent certainty the results were not because of random chance.

The initial objective of recording six weeks of intervention data was abandoned when UNL cancelled classes on March 12, 2020. The University announced that beginning March 30, 2020, classes would be moved to an online-only format. The ULC followed suit and cancelled in-person church services for the remainder of the spring 2020 semester. Without ULC services held, data could no longer be collected from ULC lunches.

Results

Six weeks of baseline data were collected during ULC lunches. Three weeks of intervention data were collected, with one of those weeks having data that was interfered with and thus led to slightly inaccurate results for that day (*Table 1*). The percentage of cups recycled for the baseline and intervention periods were 14.38% and 20.14%, respectively. The baseline data increased steadily over the 6 weeks while intervention data was more constant (*Figure 4*). The two sample t test yielded a p value of .3 which meant that the null hypothesis could not be rejected (*Table 2*).

Week	Cups Distributed	Cups recycled	Weekly Percentage (%)	Overall Percentages (%)	Notes
1	31	1*	3.22	Baseline Percentage: 14.38	Day before school resumed
2	39	1*	2.56		Martin Luther King Jr. Day; 3-day weekend
3	71	10*	14.08		Local High schoolers attended
4	47	5	10.64		Community Service Sunday
5	45	12*	26.67		None
6	59	13*	22.03		None
7	53	10*	18.87	Intervention Percentage: 20.14	None
8	69	16	23.19		Community Service Sunday
9	22**	3	13.64		Number of cups distributed was not properly counted

Table 1: Data collected for cups recycled as a percentage of cups distributed. Any notes on the conditions of the Sunday were recorded to account for any outliers. Community Service Sundays normally have fewer members of the chapel and more members of the community like high schoolers and members of other churches.

*: A cup was recycled by a member of ULC who had specific knowledge of the experiment and its methods

**: The number of cups distributed in week 9 was not accurate. The count was inaccurate because of a miscommunication with those serving lunch. The actual number could be ± 5 cups distributed.

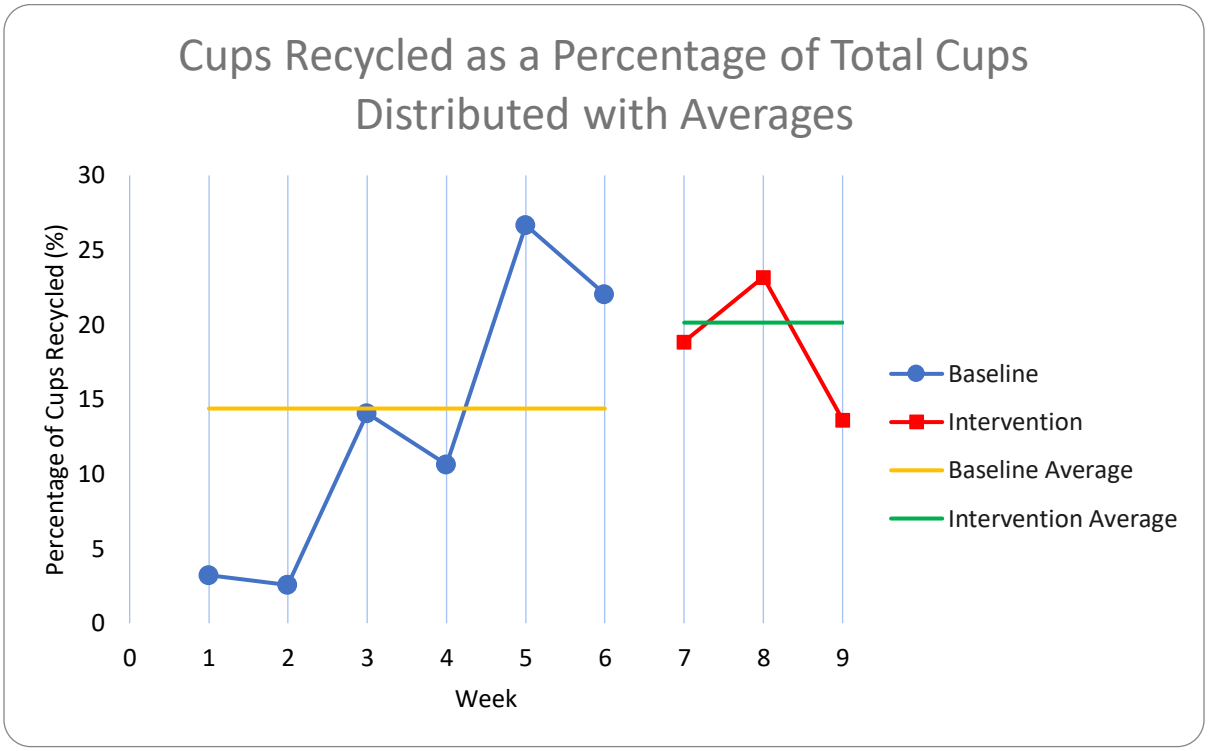

Figure 4. Percentage of cups recycled per week. Percentage was calculated by dividing the number of cups placed in a recycling bin by the number that were distributed during the lunch period. Averages were calculated by dividing the total number of cups recycled for the period by the total number of cups distributed during the period.

	Baseline	*Intervention*
Observations	6	3
Mean	0.132	0.18566667
Variance	0.009590956	0.00228696
Standard Deviation	0.097933426	0.04782221
Hypothesized Mean Difference	0	
P(T<=t) two-tail	0.305881288	

Table 2: A two-tailed two sample t test was conducted and yielded a p value of .31. With a significance level of $\alpha = .05$, the null hypothesis could not be rejected. The two sample t test used each week as one point of data and did not account for the number of cups distributed. As such, the means reflect the average of the percentages, not the overall percentage of cups recycled.

Discussion

The objective of this project was to determine whether pictorial signs increased the recycling rates of ULC over only the inclusion of the recycling symbol. Based on the results of the two-sided two sample t-test, the findings fail to reject the null hypothesis that the baseline and intervention percentages are the same. The t-test yielded a p value of .3 which means there is only 70% confidence the intervention was statistically different than the baseline. For the null hypothesis to be rejected, a p-value below .05 (95% confidence) would have been needed. Since the null hypothesis was not rejected, the reason for why that was the case should be investigated. There are several reasons why the signs may have not had the intended impact on individuals' behavior including: injunctive norms created during the baseline testing, the design of the sign, and the length of the experiment.

Firstly, it is possible that I inadvertently created an injunctive norm on recycling while distributing cups. During the experiment, I sat next to the cups or roamed while keeping my attention on the cups. When someone would reach for cups that were not already set out, I would react quickly to make sure the count wasn't altered. I am a respected member of ULC leadership; I was the president of ULC for a year in addition to living in the Chapel during the experiment as an intern to help with all Chapel events. I am a member of the ULC community that is looked up to. On occasions, I would be asked about what I was working on. Many people knew that the cups had to do my thesis, which spread by word of mouth. As a result, people tried to guess what was being observed and act according to that. Members of ULC would say things like, "Just so you know, I didn't use a cup today. I drank from the fountain instead," thinking that the project was based on individuals' use of cups in general. While no one spoke up and specifically mentioned that they recycled their cup, it's likely that the same thought process was had. This shows that people went out of their way to change their behavior for the benefit of someone they respected. As discussed in the literature review, injunctive norms occur when people change their behavior to either gain the favor or avoid the displeasure of someone they respect. Regardless of whether the individuals were avoiding scorn or hoping for praise, the result it the same; they change their behavior not because of their own inclination, but the inclination of others. An injunctive norm that caught on over several weeks would explain why the baseline numbers rose steadily throughout the period.

The type an appearance of the sign may have also had an effect. Members attending lunch were observed during both the baseline and intervention period, which included observing individuals as they chose to recycle or throw items away. During the baseline testing, no one was observed throwing away any plastic utensils. After the signs were posted above the trash and recycling stations, individuals were observed recycling plastic utensils. As shown in *Figure 3*, plastic utensils are listed under the section for "What NOT to Recycle." This may point to the signs being overly complex. Perhaps individuals did not take the time to fully read the sign or even look at the words; their eyes went straight to the pictures and they acted accordingly. Similarly, the sign could be so crowded by pictures that the individual did not notice the cup on the graphic identical to the one used in the experiment. One counterargument to this point would be the change in recycling of styrofoam. Before signs were hung, styrofoam cups for coffee were recycled often. After the posting of the signs, observed styrofoam cups improperly placed in recycling bins decreased from approximately five per week to approximately one per week. Additionally, the sign may have been too small; perhaps a standard sheet of printer paper is too small to catch the individual's eye before they drop their waste in the bins. These shortcomings with the signs posted could all be reasons why the intervention did not yield a drastic, statistically significant increase in recycling rates over the baseline.

Finally, the length of the experiment could be the reason that the intervention was not statistically different than the baseline testing. Given more time, the baseline period would have lasted for more than six weeks. Baseline percentages would have been recorded one the baseline values had leveled out. If that had happened, the variance of the baseline would have been smaller and could have led to a result that was statistically significant. If the intervention period had lasted for more than three weeks, that might have also yielded a significant result. Having a larger sample size with the same percentages and averages would have made the confidence higher.

Conclusion

While the results of the experiment did not conclude that the signs had an impact on recycling rates, the roles of the signs are still important. As discussed earlier in the works from Wilcox and Hornik, a lack of education is a primary reason why people do not recycle. Whether their lack of knowledge is about services available or how to recycle, any method used to educate is a useful tool. The 4 signs used in this experiment cost $20 dollars to print and laminate, while a new, more attractive recycling station can cost upwards of $1000. Hanging signs is an inexpensive way to begin the education process. To supplement the signs, other educational tools like infographics, videos, and brief instruction can be useful in improving education on the topic of recycling in the hopes that participation improves.

To improve upon this study, many changes could be made for future data collection. Firstly, a survey could be used to identify trends about recycling education before and after the signs are distributed. In addition to recycling statistics, a survey would provide another source of data on how individuals' behaviors change with the addition of the signs. Qualitative questions such as feelings about recycling or a list of things recycled recently at the chapel could be taken. Some of those responses could even be looked at quantitatively. For instance, if 7/10 people listed cups among the things they have recycled at the chapel that week, that number could be compared to the 2/10 people from weeks before. Other quantitative data could be gathered from the survey by asking the subject to rate their feelings about recycling on a rating scale. The average score for feelings towards recycling could be compared before and after the intervention. Similarly, there could be a quiz about knowledge of recyclable materials before and after to see if the signs had the educational impact intended.

Another way the study could be improved is by intentionally making the methods of the experiment centered around forming norms. Instead of focusing on educating through signs, the experiment could be influencing through respected figures. Recycling rates could be calculated before and after the respected figure asks the group to recycle. In the case of The Chapel, the pastor could ask the congregation to recycle their cups after lunch during the intervention period. To see the effect of the pastor's influence, there could be a third period

where the pastor is either not present for church for a couple weeks or does not ask the congregation to recycle. It is possible that the congregation would decrease their recycling participation while the pastor is not present.

While it can not be concluded that the signs had an impact on this setting, it remains to be seen if they would have an impact had the setting been altered, as mentioned in the discussion. More research needs to be done about increasing recycling participation in universities and churches alike. With deeper investigation, there can be a deeper understanding of how we, as a society can make plastic pollution and production have less of an impact on our world.

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